REMARKS

Information Disclosure Statement

Applicant notes the Office Action Summary acknowledged the Examiner's review of the Information Disclosure Statement(s) submitted on 2/4/2004, 12/22/2004, and 3/11/2005.

Drawings

Applicant notes the Office Action Summary noted an acceptance of the drawings.

Claims Objection - 37 CFR §1.126

The Office properly noted that the claims were misnumbered, wherein the Applicant thanks the Office for their careful attention in this matter. The Office renumbered the claims correctly as noted in the claim listing presented herein.

Claims Rejections - 35 USC §112 Second Paragraph

The Office rejected Claims 4, 13, 14 and 16 under 35 USC 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the applicant regards as the invention. A §112 second paragraph rejection has two separate requirements, indefiniteness and failing to claim what applicant regards as the invention. With respect to indefiniteness, the "essential inquiry pertaining to this requirement is whether the claims set out and circumscribe a particular subject matter with a reasonable degree of clarity and particularity. Definiteness of claim language must be analyzed, not in a vacuum, but in light of (1) the content of the particular disclosure, (2) the teachings of the prior art, and (3) the claim interpretation that would be given by one possessing the ordinary level of skill in the pertinent art at the time the invention was made." (MPEP §2173.02).

A rejection stating that the claims fail to set forth the subject matter that the applicant regards as the invention is only appropriate where the applicant has stated that the invention is something different from what is defined by the claims (MPEP §2172(a)). Furthermore, there is a presumption that the claims describe the applicant's invention, absent evidence to the contrary.

In more particular detail, the Office has rejected the term "Enhanced Conduction Angle" (ECA) used in the specification and claims. The Office made an assumption that the ECA is the equivalent of typical Power Factor Correction (PFC) schemes. PFC is explained in further detail herein in comparison ECA and the distinctions are noted.

Applicant refers the Office to the commonly-assigned issued patent entitled "Enhanced Conduction Angle Power Factor Correction Topology", U.S. Pat. No. 6,567,283; as well as U.S. Pat. No. 6,879,053 and related U.S. Pat. No. 6,969,922. All of which describe the ECA in further detail. The background is important to understanding the present invention, therefore a detailed explanation is provided herein.

Technically, power factor is defined as the ratio of the real power (P) to apparent power (S), or the cosine (for pure sine wave for both current and voltage) that represents the phase angle between the current and voltage waveforms. The technical definition of power factor is directly related to the phase angle for ideal sinusoidal waveforms for both current and voltage. However, most power supplies draw a non-sinusoidal current, thus when the current is not sinusoidal and the voltage is sinusoidal, the power factor consists of two factors: 1) the displacement factor related to phase angle and 2) the distortion factor related to wave shape.

The power factor varies between 0 and 1, and can be either inductive (lagging) or capacitive (leading). Ideally, when the current and voltage waveforms are in phase, the power factor is 1. The PF is important as the output power Pout = VL(RMS) x IL(RMS) x PF x Efficiency – so the closer the PF is to unity, the better the efficiency. It is important to distinguish PF from Power Factor Correction (PFC).

The purpose of the Power Factor Correction (PFC) design is to minimize the input current distortion and make the current in phase with the voltage thereby 'correcting' the power factor to unity. Expressed differently, the general purpose of power factor correction is to make the circuit look purely resistive (apparent power equal to real power) to obtain a unity PF. When the power factor is not equal to 1, the current waveform does not follow the voltage waveform. This results not only in power losses, but may also cause harmonics that travel down the neutral line and disrupt other devices connected to the line. The closer the power factor is to 1, the closer the current harmonics will be to zero since all the power is contained in the fundamental frequency.

PFC topologies, such as those cited by the Office, are typically based on input V and control of the input I so the phase is lined up with input voltage to make the PF = 1.

In contrast, ECA is a unique PFC concept according to certain design criteria. The ECA does provide enhanced PF as compared to regular rectifier schemes with decent PF (not unity), however it is a less complex scheme than the PFC designs. At maximum power the ECA establishes a PF that is close to unity but at low power PF is less efficient.

Several prior art PF schemes are identified and described in Figures 1-3 in U.S. Pat. No. 6,567,283 showing the circuits applicable thereto, and explaining the problems with such designs. Figures 4a-e shows the various AC waveforms showing the three phase relationship to each other and to the zero crossing.

There are numerous embodiments applicable to the ECA, as noted in the U.S. Pat. No. 6,567,283 Figure 5 description shown herein for convenience, "[b]y placing the boost impedance before the rectifier 100, as shown in FIG. 5, it is possible to <u>extend the maximum conduction angle</u> from $2/3\pi$ to nearly continuous π. This is primarily because the individual inductors L1-L3 allow the boost switch SW to switch against each phase individually. The three inductors L1-L3 act to drop the applied line voltage phases independently, but simultaneously. This allows a much lower THD and PF of the input power. Thus, more closely matching the ideal situation of

FIG. 4c, which demonstrates the **enhanced conduction angle**. (U.S. Pat. No. 6,567,283, Col. 6, beginning on line 65 (emphasis added))

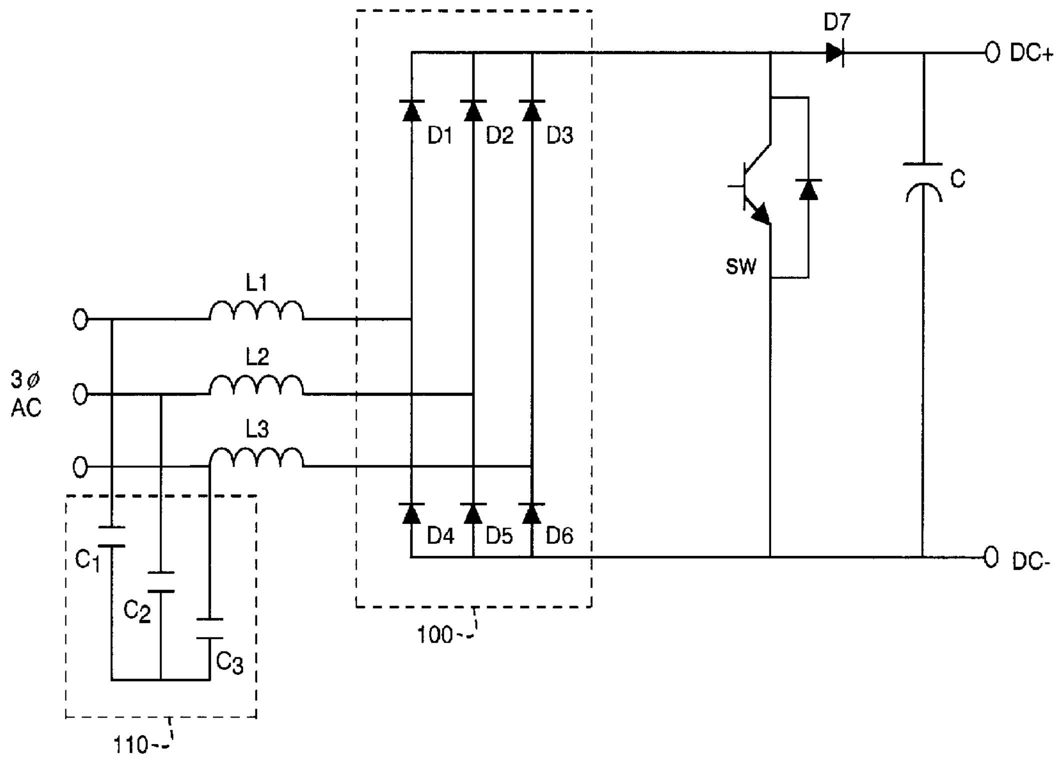

FIG. 5

As detailed in U.S. Pat. No. 6,969,922, one example of a VSG design with an ECA dual boost is described in relation to U.S. Pat. No. 6,969,922 Figure 1, which is included herein for convenience. "Referring again to FIG. 1, in addition to the power conditions system 20, 30, the variable speed generator (VSG) includes a transformerless AC PWM inverter 800 and inverter control 810 that couples to the load 50. There is an ***enhanced conduction angle*** (ECA) dual boost DC bus voltage regulator 700 and dual boost control section 710 for power conditioning. The generator 600 and internal combustion (IC) engine 500 are coupled to the ECA 700 which provides the DC output to the inverter 800 that is tied to the load 50. The generator 600 can

employ a field winding 420 for synchronous type generators. There are various interconnection techniques to tie the inverter 800 to the load and grid 50 as is known in the art.

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Within the DSP card 20, the VSG engine primary speed command generator section 100 receives actual output power feedback 110 from the PWM inverter processor 810. In one embodiment, there is a speed versus load user-programmable lookup table (not shown) that has pre-programmed points that make a curve of optimum engine speed versus load for a given application. The inverter control 810 calculates each AC phase current, voltage and phase angle of the load 50 and sends the actual "real" power out signal (PWR out) 110 to the speed command generator 100. The actual load defines the optimum engine speed for a given "actual load power" as the speed command generator 100 has apriori engine performance characteristics such as the minimum and maximum speed (Min SPD and Max SPD) of the generator 500. The speed command generator 100 also encompasses a speed feedback signal (SPD feedback) and a throttle position feedback that can be used to control system performance. The output of the speed command generator 100 is the actual speed command (SPD CMD) that represents the amount of power and engine speed required to achieve a no load shed condition, which is the full output AC voltage and thus full load required power. In one variation there is a VSG engine secondary "speed command generator" that resides in the DSP/Inverter 810 that is used for extreme load transients.

In the speed summer 210, the speed command 200 is summed with the speed feedback (SPD feedback) 270. The speed feedback 270 is obtained from the frequency to voltage converter 260 which receives the engine speed feedback from the speed sensor pick up 400 that couples to the engine 500. Alternative speed sensors, such as zero crossing detectors connected to the generator magneto and tachometers are also within the scope of the invention.

The throttle control system interacts with an electro-mechanical throttle actuator 410 that is based on throttle current for use in fuel consumption and emissions applications. As part of the throttle feedback system, one of the outputs of the proportional integral (PI) speed summing amplifier 210 is the speed error signal, which is fed to the speed loop gains PI amplifier 220 where the signal is processed and amplified. The speed loop gains output signal 230 is coupled to the throttle pulse width modulator (PWM) 240 that processes the throttle signal sent to the engine throttle valve actuator 410 via PWM amplifier 250. The throttle valve actuator 410 adjusts the throttle (not shown) on the engine 500 to adjust for changes in the load requirements.

A signal from the speed summer 210 may optionally be fed to the load shed estimator 300 via the speed loop gains section 220. The load shed estimator 300 sums the signal from the speed summer 210 with a signal 315 from the DC/DC dual boost regulator control 710 that represents the percentage beneath the current limit. The load shed estimator 300 has an independent PI amplifier for each input signal 280 and 315, wherein the outputs are summed together to provide the optional load shed term (LST) 320.

The LST (load shed term) 320 is fed to the PWM inverter controller 810, wherein the AC voltage command is reduced to adjust the output AC PWM voltage PWM signals sent to the inverter power stage 800 for the purpose of shedding VSG engine/generator load by decreasing output AC voltage. The LST (load shed term) 320 is also fed to the speed command generator 100 for use in calculating the desired power out.

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The present invention provides a regulated high quality fixed frequency, low total harmonic distortion (THD), 3-phase 3-wire, or 3-phase 4-wire (includes neutral phase), AC power output to a load for the efficient conversion of power from a variable speed/variable frequency generator. The invention also provides single-phase 2-wire, or single-phase 3-wire (includes neutral phase) AC power output to a load.

The invention includes a means for automatically regulating the generator at the optimum speed/frequency and voltage for a given load such that excessive frictional, pumping, and windage and other parasitic engine losses are not incurred, especially when feeding relatively light loads."

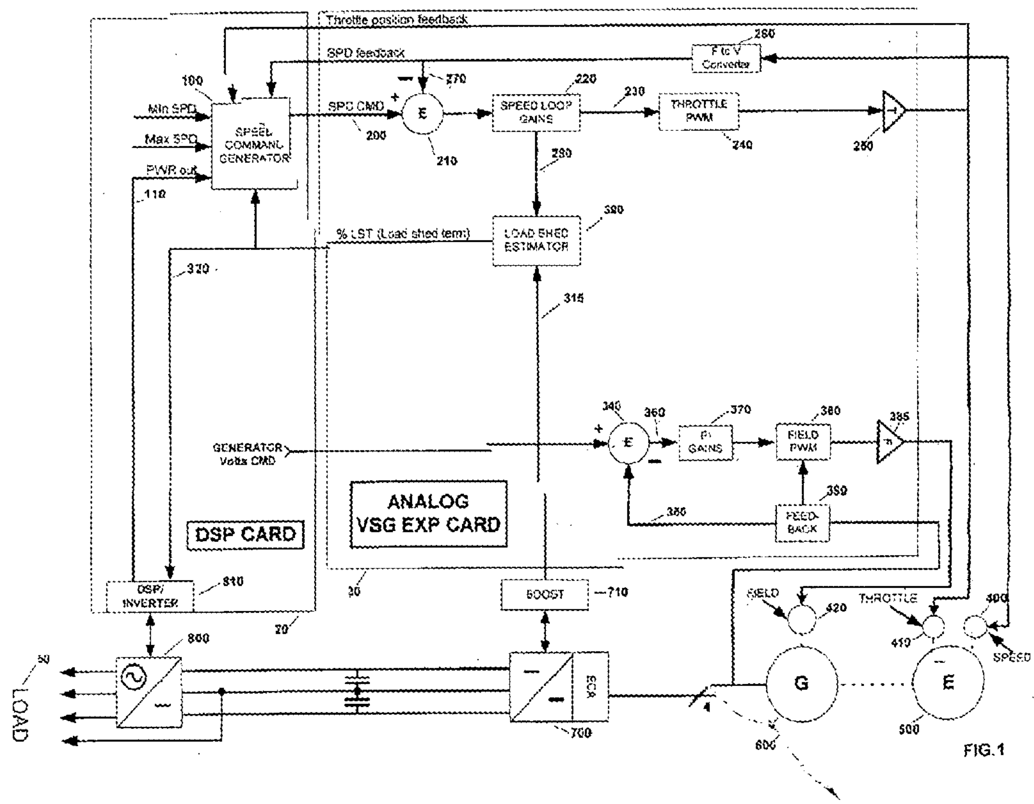

FIG. 1

The Office also finds the term "dual boost" to be unclear and requests clarification. As detailed herein and in the commonly assigned issued patents, the basic dual boost is described for Figure 4 in U.S. Pat. No. 6,567,283. "FIG. 2 illustrates a basic schematic of a three phase four wire scheme with ***dual boost***. Once again, the inductors L1 and L2 are connected after the rectifier section 20. The switches SW1 and SW2 control the current flow and charging of the

inductors L1 and L2 that are discharged into C1 and C2 respectively with the DC output level formed from the output capacitors C1 and C2."

3 PHASE, 4 WIRE WITH DUAL BOOST/PF CORRECTION

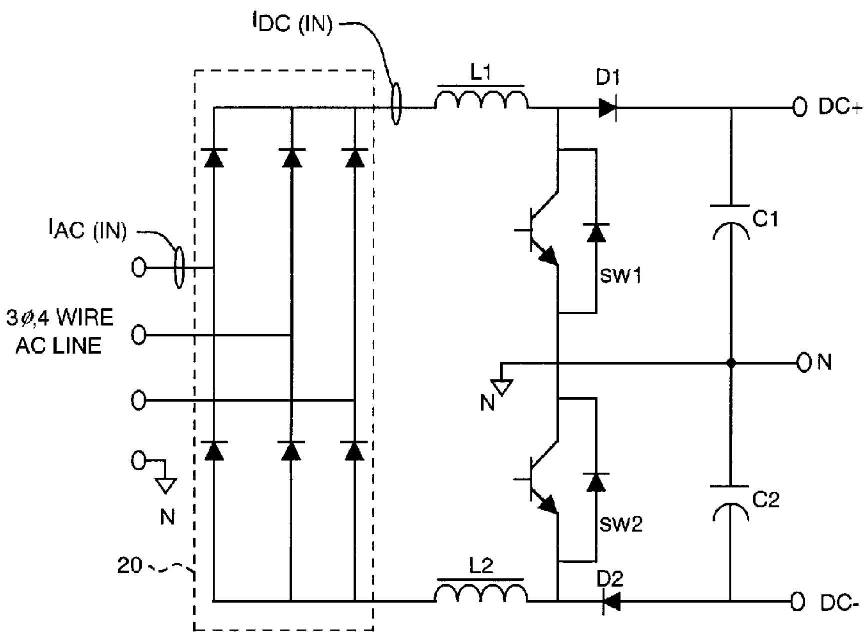

FIG. 2
(PRIOR ART)

The Office also finds the term "feeding" to be unclear and requests clarification. The term feeding is generally known in the art and refers to electrically coupling, typically used with respect to feeding a load from a power source. As described on page 3, paragraph 0011, "[p]ower converters, such as inverters, are necessary in modern power systems and especially for the new energy generating devices such as photovoltaic devices, micro-turbines, variable speed internal combustion (IC) engines, fuel cells, and superconducting storage. These devices generate AC or DC electricity that needs to be converted to a conditioned AC for **feeding** into the power grid or for direct connection to loads." With respect to claim 13 and 14, "feeding" the hybrid uninterruptible power supply refers to providing power to this section as shown in Fig. 2 of the present invention, wherein the hybrid uninterruptible power supply comprises the ECA, Inverter and ESM. The AC line normally may feed this section, however under certain

circumstances the VSG may feed this section. The hybrid uninterruptible power supply system feeds the load.

The Office has also requested a clarification of the energy storage module and its relationship to the hybrid uninterruptible power supply. The ESM is within the hybrid uninterruptible power supply system – however it normally does not feed the load. If the AC input line is disconnected/unavailable, the VSG normally kicks in to feed the load. However there may be a time lag until the VSG can come up to power sufficient to feed the load, and the ESM can temporarily feed the load. Claim 13 has been amended to clarify this relationship. The Applicant believes that the rejections have been traversed and requests reconsideration.

Claim Rejections – 35 USC § 103

The Office has quoted the statute from 35 USC 103(a), which is referenced herein. The Office has rejected claim 1-3, 5-12, 15 and 16 as being unpatentable over Koenig (U.S. Pat. No. 6,737,762) in view of Van Sickle (U.S. Pat. No. 5,811,960). Applicant has carefully considered the Office rejections and respectfully submits that the amended claims, as supported by the arguments herein, are distinguishable from the cited reference.

According to the MPEP §2143.01, "[o]bviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found in either the references themselves or in the knowledge generally available to one of ordinary skill in the art."

A useful presentation for the proper standard for determining obviousness under 35 USC §103(a) can be illustrated as follows:

1. Determining the scope and contents of the prior art;
2. Ascertaining the differences between the prior art and the claims at issue;
3. Resolving the level of ordinary skill in the pertinent art; and

4. Considering objective evidence present in the application indicating obviousness or unobviousness.

The Koenig reference refers to a power generation system which includes a variable speed generator and rectifier circuit wherein the engine speed depends on amount output power. There is no direct control of the engine or calculating of speed the engine as "Generator 104 runs at a speed sufficient to maintain the DC voltage at node/bus 112 while delivering steady-state power to load 102, and while converter 118 stores energy in energy storage device 116 by downwardly translating the voltage level at node/bus 112. Then, when the power drawn by load 102 increases more rapidly than generator 104 and rectifier 106 can sustain the DC voltage at node/bus 112, converter 118 transfers energy from energy storage device 116 to node/bus 112 by performing a boost voltage translation. During this time, generator 104 accelerates to the speed needed to accommodate the increased power drawn by load 102." (Koenig, Col 2, lines 39-51)

In distinction, as noted in the amended claims, the present invention has direct control of the engine using speed and based upon power measurements wherein the desired speed is processed using a lookup table of table values for load versus engine speed. As noted in the description accompanying Figure 6 of the present invention, the lookup table has table values representing a set of points on a curve of engine speed versus load. The curve can be directed to a specific application such as emissions, efficiency, audible noise and transient load response depending upon the design criteria.

For at least these reasons, the Applicant believes that the amended claims traverse the rejections and reconsideration and allowance is respectfully requested.

The Office rejects claim 4 under 35 USC 103(a) as being unpatentable over Koenig in view of Van Sickle and Symonds (U.S. Pat. No. 5,610,451). The Office acknowledges that Koenig fails to teach a boost DC bus voltage regulator and alleges that Symonds teaches such a regulator. However, as noted herein, the enhanced conduction angle dual boost DC bus voltage regulator is not described in Symonds. The ECA power factor correction scheme is not

described in any of the cited references, thus the limitation of the regulator section being an ECA dual boost DC bus voltage regulator is not obvious in combination with any of the references and reconsideration is requested.

The Office also rejects Claim 17 using Koenig in combination with Van Sickel and Symonds, however the Applicant argues that this combination does not approach the features of the present invention. Claim 17 notes that the hybrid UPS power supply incorporates an enhanced conduction angle (ECA) dual boost DC regulator section coupled to an inverter with an energy storage module coupled therebetween. However, the reliance upon Symonds is misplaced and nothing in this reference describes the ECA dual boost DC regulator.

With respect to Claim 14, the load shed term refers to a calculated value of power that is fed to the inverter for the purpose of shedding VSG engine/generator load by decreasing output AC voltage. There is nothing noted in any of the references in relation to a load shed term.

For at least the reasons set forth herein the rejections of the claims is hereby traversed and reconsideration and allowance is respectfully requested.

Telephone Interview

Present Office policy places great emphasis on telephone interviews initiated by the examiner. For this reason, it is not necessary for an attorney to request a telephone interview. Examiners are not required to note or acknowledge requests for telephone calls or state reasons why such proposed telephone interviews would not be considered effective to advance prosecution. However, it is desirable for an attorney to call the examiner if the attorney feels the call will be beneficial to advance prosecution of the application. MPEP§408

Applicant believes the above amendments and remarks to be fully responsive to the Office Action, thereby placing this application in condition for allowance. No new matter is

added. Applicant requests speedy reconsideration, and further requests that Examiner contact its attorney by telephone, facsimile, or email for quickest resolution, if there are any remaining issues.

Respectfully submitted,

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